EFFECT OF PALM OIL FUEL ASH (POFA) FOR FIBER REINFORCED CONCRETE TOWARDS CORROSION RESISTANCE

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SUPERVISOR’S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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STUDENT’S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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DEDICATION

Praise be to Allah S.W.T the Lord of the World

Who says (interpretation of meaning)

"Give thanks to me and your parent. To me is final destination"

[Quraan,Luqman 31:14]

I dedicated this research to my family especially

Mr. Bahrun bin Abd Hamid and Mrs. Salmiah binti Md Ali

For keep encourage me and for opening my eyes to the world

And to my supervisor, Dr Fadzil bin Mat Yahaya,

All friends for their endless help, patience and encouragement.

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ABSTRAK

Simen Portland Biasa (OPC) diiktiraf sebagai bahan pembinaan utama di seluruh dunia. Malaysia dikenali sebagai pengeksport terbesar minyak sawit. Abu Bahan Api Kelapa Sawit (POFA) dianggap sebagai bahan buangan yang dihasilkan oleh pembakaran sisa daripada gentian, cengkerang dan tandan. Setiap tahun, kuantiti POFA meningkat disebabkan peningkatan tanaman pokok kelapa sawit di negara kita. Menurut penyelidikan, POFA adalah sisa bahan buangan dan mempunyai potensi untuk digunakan sebagai bahan binaan dengan menggantikan Simen Portland Biasa (OPC). Dalam kajian ini, kekuatan mampatan, 'accelerated corrosion resistance' dan kebolehkerjaan konkrit serat keluli yang mengandungi Kelapa Sawit Minyak Sawit (POFA) telah diuji. Simen Portland Biasa (OPC) sebahagiannya digantikan dengan POFA pada dos sebanyak 10%, 20% dan 30% berat simen yang digunakan dan spesimen kawalan adalah 100% OPC. Dari kajian ini, didapati bahawa penggantian POFA optimum adalah 20% berat simen. Kekuatan konkrit POFA telah mencapai kekuatan sasaran iaitu 30 N / mm2 berbanding OPC. Bagi ujian 'accelerated corrosion resistance', konkrit POFA menunjukkan prestasi yang lebih baik berbanding dengan konkrit OPC. Dari hasil yang diperoleh, jelas bahawa penggantian separa oleh POFA bermanfaat, terutamanya dalam pembinaan konkrit.

ABSTRACT

Ordinary Portland Cement (OPC) is well recognized as the major construction material throughout the world. Malaysia is known as the largest exporter of the palm oil. Palm Oil Fuel Ash (POFA) is considered as a waste material produced by burning of fibers, shells and empty fruit brunches. Annually, the quantity of POFA is increased due to the increase of the plantation of palm oil trees in our country. According to the research, the agro waste, such POFA is the pozzolanic material and have the potential to be utilized as construction material by replacing the Ordinary Portland Cement (OPC). In this study, the compressive strength, the durability of corrosion resistance and workability of steel fiber concrete containing Palm Oil Fuel Ash (POFA) were tested. The Ordinary Portland Cement (OPC) was partially replaced with POFA at the dosage of 10%, 20% and 30% by weight of cement used and the control specimen is 100% OPC. From this study, it was found that, the optimum POFA replacement is 20% of cement weight. The strength of POFA concrete has achieved the targeted strength which is 30 N/mm2 compared to OPC. As for the accelerated corrosion test, POFA concrete shows better performance compare to OPC concrete. From the results obtained, it is clear that the partial replacement of cement by POFA beneficial, especially in the construction of concrete.

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LIST OF SYMBOLS

%	Percentage
μm	Micrometer
mm^2	Milimeter square
m^3	Meter cube
g	Gram
°C	Degree Celsius

LIST OF ABBREVIATIONS

BS	British standard
UMP	University Malaysia Pahang
FKASA	Fakulti Kejuruteraan Awam dan Sumber Alam
ASTM	American Society for Testing and Materials
POFA	Palm Oil Fuel Ash
OPC	Ordinary Portland cement
PC	Portland cement
CO_2	Carbon dioxide
SiO_2	Silicon oxide
Al_2O_3	Aluminium oxide
Fe_2O_3	Iron oxide
CaO	Calcium hydroxide
MgO	Magnesium oxide
K_2O	Potassium oxide
Na_2O	Natrium oxide
SO_3	Sulphur trioxide
w/c	Water cement
mm	Milimeter
min	Minute
hr	Hour

CHAPTER 1

INTRODUCTION

1.1 Background

Steel fibre reinforced concrete (SFRC) is increasingly being used in the construction of prefabricated segmental linings for bored tunnels, since it entails simplified production processes and higher-quality standards (Marcos-meson et al., 2017). SFRC is a composite material, combining a cementitious matrix and a discontinuous reinforcement, consisting of steel fibres uniformly distributed in the matrix. The use of steel fibres as partial or total replacement of conventional reinforcement bars has become a popular solution for the construction of prefabricated segmental linings for bored tunnels, due to its overall superior durability and good performance in compression.

However, international standards and guidelines are not consistent regarding the consideration of steel fibres for the structural verification of SFRC elements exposed to corrosive environments, hampering the development of civil infrastructure built of SFRC. Concrete reinforced with fibres (which are usually steel, glass or “plastic” fibres) is less expensive than hand-tied rebar, while still increasing the tensile strength many times.

It is an undeniable fact that concrete is the most widely used man-made construction material in the world today, and will remain so for decades to come. The popularity of concrete is largely due to the abundance of raw material, low manufacturing and maintenance cost, excellence in compression, and corrosion aspects, durability to weathering and fire hazards, versatility in forming various shapes and its unlimited structural applications in combination with steel reinforcement (Parande et al., 2008). In Malaysia, Ordinary Portland Cement was known as common or general-purpose cement, it is commonly used for general construction especially when making precast, and precast-pre stressed concrete that is not to be in contact with soils or ground water. However, the production of cement gives the bad impact towards environment and people. The cement production process is classified as the second biggest source that is responsible for 6.97% of CO2 emission in the world (Bamaga, Hussin, & Ismail, 2013). Additionally, carbon dioxide was created by the combustion of fossil fuels or plant matter, among other chemical processes. Carbon dioxide is one of several greenhouse gases that can cause global warming by trapping the Sun's radiant energy in our atmosphere. This process is called the greenhouse effect.

The reduction of cement content in concrete can be achieved by utilization of supplementary cementitious materials (Sooraj, 2013). The palm oil industry in Malaysia, over the last few decades, has grown in size to become an important agricultural-based industry, where the country today is the world's largest producer and exporter of palm oil (Al-mulali et al., 2015). The agro waste such POFA can be used as POFA itself possessing pozzolanic behavior which can be used as cement replacement in concrete (Raut & Gomez, 2016). Besides, many researchers have studied the use of palm oil fuel ash in concrete (Kroehong, Sinsiri, & Jaturapitakkul, 2011).

1.2 Problem statement

Nowadays, there are a lot of problems in buildings due to cracking. Cracking can be because of various factors such as because of creep, drying shrinkage, thermal movement, uneven settlement and many more. Nevertheless, what can be highlight for this research study is cracking which is happened because of corrosion that happen in steel bar reinforcement. Corrosion decreases the cross-sectional area and the strength of reinforcement. With the increase of corrosion time under aggressive environments, the increased volume of corrosion products may cause concrete cover cracking (Ma et al., 2017). Corrosion in steel happens because of the present of water and oxygen. The oxygen and water exist trough the pore that have at the concrete. When the corrosion happens, the corrosion at the steel bar will push the concrete. Because of this, the surface of the concrete will slowly crack. When corrosion is getting worst, the corroded bar will expose. This is how the corrosion in steel bar start causing the crack.

In other hand, construction and development project required usage of high amount of concrete. One of the main products required in manufacturing concrete is cement. Cement production is consuming significant amount of natural resources, with the increase of the cement will lead to the increasing of the carbon dioxide on earth. Ordinary Portland Cement (OPC) is one of the famous type used in construction. The primary component in produce cement is limestone. The heating of limestone will release carbon dioxide (CO_2) directly. The production of cement will release greenhouse gas emissions directly and indirectly.

Malaysia is a major contributor of palm oil. In 2007, approximately 3 million tons of POFA were produced in Malaysia alone and this production rate is likely to rise due to the increased size of the palm oil tree plantations around the country (Mohammadhosseini et al., 2017). Most of the POFA was disposed of as waste. The waste that been disposed in landfill will create problems to the environment.

Therefore, research about the using of POFA as cement replacement and steel fibre reinforced concrete is necessary since POFA itself have the potential to recover the corrosion in steel reinforcement bar.

1.3 Research objectives

The main objectives of this study are:

i. To determine the effect of Palm Oil Fuel Ash (POFA) and steel fibre on workability.
ii. To determine the effect of Palm Oil Fuel Ash (POFA) and steel fibre towards concrete strength.
iii. To determine the effect of Palm Oil Fuel Ash (POFA) and steel fibre on corrosion resistance of steel reinforcement in concrete.

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